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methods for enclosing and managing outside plant equipment with cross-connect and interconnect functions. There is also a need for enclosing and managing fiber optic splice locations and optical couplers.

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### Summary of the Invention

An optical fiber distribution frame apparatus includes a frame member having upper and lower module mounting brackets and an interior. The upper and lower module mounting brackets are spaced apart to define a space for receipt of a plurality of fiber optic modules mounted to the frame member. Each module includes a front and two mounting flanges. Each mounting flange is mountable to one of the upper and lower module mounting brackets.

The modules are provided with one or more functions. One of the modules defines a connection module and further includes a rear spaced from the front, a spaced apart top and bottom positioned adjacent to the flanges, and spaced apart sides.

15 The connection module is configured and arranged for housing a plurality of connection locations having exposed openings along the front arranged in one or more vertical arrays. The bottom, the rear, and the opposed sides of the connection module define a cable notch region, wherein the cable notch region includes an opening for a first cable to enter the module. The first cable is connectable to the connection locations within an interior of the connection module either directly or through optical couplers. A further module defines a storage module including first and second spools positioned on the front.

The connection locations preferably define adapters for connection to connectors of fiber optic cables. Preferably, the adapters are angled downwardly when the connection module is mounted to the frame member.

An enclosure is preferably provided to surround the frame member for use in an outside plant application. In the case of configuring the optical fiber distribution frame apparatus as an interconnect system, the storage module preferably includes a cable clamp positioned on the front for clamping a second cable, wherein the

second cable is connectable to the connection locations on the connector module. The frame member preferably has a cable tray and an opening sized for receipt of the second cable. The interconnect system may also include a blank or filler module defining a generally planar front.

- 5                    In the case of configuring the optical fiber distribution frame apparatus as a cross-connect system, two connection modules are provided, and the storage module is positioned between the two connection modules. One or more patch cords link the connection locations of the two connection modules.

- 10                   The present invention also relates to a method of assembling an optical fiber distribution frame including the steps of providing a frame member, and selecting a plurality of fiber optic modules for mounting to the frame. The fiber optic modules are selected so as to fill the frame member with desired functions. Connection modules, storage modules, and blank or filler modules can be selected as desired. In the case of a cross-connect system, two connection modules are mounted to the frame member, with  
15 a storage module positioned between the two connection modules and mounted to the frame member in one embodiment. In the case of an interconnect system, a connection module is mounted to the frame member, as well as a storage module in another embodiment.

- 20                   The present invention also relates to individual components comprising an optical fiber distribution frame apparatus. A frame member defines an interior, and includes an open front bounded by upper and lower module mounting brackets. The lower module mounting brackets further include a plurality of openings configured and arranged for receiving cable.

- 25                   A connection module in accordance with the present invention includes a front and two mounting flanges. A rear of the module is spaced from the front. A top and bottom are positioned adjacent to the flanges, and opposed spaced apart sides define an enclosed interior for the connection module. The connection module interior houses a plurality of connection locations having exposed openings along the front. The

bottom, the rear, and the opposed sides define a cable notch region wherein the cable notch region defines an opening for receiving a first cable.

A storage module in accordance with the present invention includes a front and two mounting flanges, and first and second spools in alignment extending  
5 between the two mounting flanges. Side edges of the front further include projecting cable guides. In the case of a storage module for use in an interconnect system, a cable clamp is also positioned on the front for clamping a cable.

Blank or filler modules are also provided in accordance with the invention to fill unused space of the frame member. Each blank module includes a  
10 generally planar front, and two mounting flanges. Side flanges extend in an opposite direction to the direction faced by the front.

The connection module may house within its interior a splice between the first cable entering the module through the cable notch region, and the individual cables leading to the connection locations on the front of the module or to one or more  
15 optical couplers housed within the interior of the module. Example couplers include optical splitters and wavelength division multiplexers.

#### Brief Description of the Drawings

FIG. 1 is a front view of a fiber distribution apparatus in a cross-connect  
20 configuration, with portions of the enclosure and the cover removed.

FIG. 2 is a front view of a fiber distribution apparatus in an interconnect configuration, with portions of the enclosure and the cover removed.

FIG. 3 shows the cross-connect fiber distribution apparatus of FIG. 1 including exemplary fibers in place.

25 FIG. 4 shows the interconnect fiber distribution apparatus of FIG. 1 including exemplary fibers in place.

FIG. 5 is an exploded perspective view of the frame and the cover.

FIG. 6 is a side view showing the cover mounted to the frame.

FIG. 7 is a front view of the frame.



### Detailed Description of the Preferred Embodiments

Referring now to FIGS. 1 and 3, a fiber distribution apparatus 10 is shown for use in cross-connect applications. FIGS. 2 and 4 show a similar fiber distribution apparatus 10' configured for interconnect applications. Both apparatus 10, 10' include an outer enclosure 20, and an inner frame 22 including a plurality of optical modules 23 mounted thereto. As will be described below in greater detail, modules 23 have particular functions, and apparatus 10, 10' is preferably provided with different modules 23 selected to have the desired functions for the particular application.

Enclosure 20 typically extends from the ground over underground cables 300, 302 (FIG. 3) and 400, 402 (FIG. 4) which extend upwardly from the ground and contain multiple individual optical fibers or bundles of fibers. Cables 300, 302, 400, 402 may be single cables or multiple cables. Enclosure 20 protects the inner components, in this case fiber optic telecommunications equipment. Enclosure 20 can be any convenient structure sized to protect frame 22 and modules 23. In the drawings, enclosure 20 includes a main vertical portion 40 extending from the ground and a top cap 42. Typically, a movable front door is provided, and a lock provides secure access.

Referring now to FIGS. 1-7, frame 22 is secured to main portion 40 of enclosure 20 along a rear side 41 of main portion 40. Frame 22 includes a base or bottom 50, and an opposed top 52. Frame 22 further includes a front 54, and an opposed rear 56, and spaced apart sides 58. Rear 56 of frame 22 can be screwed, riveted, or otherwise fastened to rear side 41 of main portion 40 of enclosure 20 through holes 62.

Frame 22 further includes an upper module mounting bracket 66, and a lower module mounting bracket 68 extending between sides 58. Each module mounting bracket 66, 68 receives a plurality of modules 23 connected via fasteners 70, such as screws, or other fasteners. Preferably, the fasteners are releasable to enable removal of modules 23, as desired, such as for repair, or replacement. Each of the module mounting brackets 66, 68 includes a plurality of holes 67, 69 for receipt of fasteners 70.

Lower module mounting bracket 68 defines a cable tray 60 (FIG. 5) including a plurality of lower holes 72, each sized for receipt of one or more cables, as will be described in greater detail below.

A cover 76 (FIGS. 5 and 6) mounts to frame 22 so as to close front 74.

- 5 Side flanges 78 of cover 76 include a plurality of downwardly angled slots 80 for receipt of pins 82 extending from sides 58, 60 of frame 22. Nuts, such as wing nuts, can be mounted to pins 82 with threads to help secure cover 76 to frame 22.

Referring now to FIGS. 1-4, and 8-12, a connection module 24 is shown. Connection module 24 comprises one of modules 23. Connection module 24 includes a  
10 front 90 defining a plurality of connection locations 91. Front 90 also includes opposed mounting flanges 92, 94 extending along front 90 for mounting to module mounting brackets 66, 68 of frame 22. Each of flanges 92, 94 includes a plurality of holes 96, 98 for receiving fasteners 70. A spaced apart rear 100 of connection module 24, and a spaced apart top 102 and bottom 104, and opposed, spaced apart sides 106, 108 define  
15 an interior region. A cable notch 110 formed by portion of rear 100, bottom 104, and sides 106, 108 receives a cable 300 for connection to the connection locations 91 within the interior of module 24. Notch 110 further includes an opening 112 for cable 300. Opening 112 is large enough to receive one or more additional cables.

Each of the connection locations 91 preferably includes an adapter 200  
20 for mounting to a fiber optic connector, such as an SC (shown), an ST, an FC, or other connector. Cable 300 entering connector module 24 at opening 112 includes its individual fibers connected to the individual connection locations 91, as desired. Two illustrated example fibers 300a, 300b of cable 300 connect to two connection locations 91. A connector 208 (FIG. 11) is preferably on an end of fibers 300a, 300b. Adapter  
25 200 preferably has two ends 202 and 204. End 202 is disposed within module 24 for connection to connector 208. Opposite end 204 defines the exposed opening of the connection location 91 along the front of module 24 for connection to a second connector 218. A clip 210, such as the clip disclosed in U.S. Patent No. 5,214,735 may be used to releasably attach each adapter to module 24. Clip 210 also angles connection

locations 91 downwardly when module 24 is installed in frame 22 as in the drawings. Each clip 210 holds each adapter 200 in one of the openings 93 of front 90 of module 24 to define each connection location in the preferred embodiment. In the illustrated embodiment of module 24, only two connection locations 91 are shown, but a fully loaded module 24 would define a connection location 91 at each opening 93. Clip 210 is preferably a snap mounted clip to enable easy assembly. A removable clip 210 is preferred to allow cleaning of connector 208 and end 202 if desired.

A similarly configured second connection module 24a is mounted to frame 22 to permit cross-connection through the use of patch cords 114a, 114b (FIG. 3) to cross-connect between the fibers of each cable connected to the respective connection modules 24, 24a. Cable 302 is connected to the rear of module 24a as cable 300 is for module 24. Patch cords 114a, 114b, and fibers 300a, 300b are shown schematically in FIGS. 3 and 9, but each fiber has a connector like connectors 208, 218 to mate with adapter 200. Alternatively, other connector systems as noted above can be used, as desired.

Each connection module 24, 24a can be made of sheet metal sections, held together with fasteners, such as screws, so as to allow access as desired to the interior of each module.

To facilitate cable management, and cable protection, a cross-connect storage module 26 as one of modules 23 is provided having three spools 116 along a front 120 (FIGS. 1, 3 and 20). Along a front 120 of an interconnect storage module 26a as one of modules 23 is provided two spools 116 (FIGS. 2, 4 and 21). Flanges 124, 126 permit mounting of each storage module 26, 26a to frame 22 in a similar manner as modules 24, 24a. Holes 128, 130 receive fasteners 70 to mount storage modules 26, 26a to frame 22. Front projections 118 along vertical side edges 117 further enable cable management and cable protection during use. A cable clamp 134 (FIG. 4) is provided for front mounting of one or more cables to storage module 26a for the interconnect system. Posts 135 (FIG. 21) hold the clamp pieces.



Cable notch 110 is useful to avoid excess cable bending during manipulation and positioning of connection modules 24. The use of notch 110 provides a greater distance between the cables extending upward from the ground to the clamp mounting locations on modules 24. The extra distance is advantageous when

5 manipulating module 24 as it is installed into or removed from frame 22.

In the example cross-connect system of FIG. 3, two fibers 300a, 300b (FIG. 9) of cable 300 are shown as optically linked to two fibers of cable 302 through patch cords 114a, 114b in a cross-connect application between modules 24, 24a. In the example interconnect system of FIG. 4, two fibers 402a, 402b of cable 400 are shown as  
10 optically linked to two fibers of cable 400.

Referring now to FIGS. 18 and 19, alternative connection modules 224, 226 include different numbers of vertical rows of connector locations 91. Modules 24, 24a included two vertical rows. Connection module 224 includes a single row of connection locations 91, and connection module 226 includes three. Four or more rows  
15 are also possible.

Referring now to FIGS. 13-17, module 24 is shown as including optical components such as splices and/or optical couplers within the module between cable 300, and connection locations 91. In FIGS. 13 and 14, a splice 350 to a one-by-two optical splitter 351 allows for module 24 to have line and monitor functions associated  
20 with connection locations 91. Row 352 of connection locations 91 could serve as the line function, and row 354 could serve as the monitor function. Each pair of connection locations 91 (one from each row) would be linked to one of the fibers of cable 300 in FIG. 13. Other splitters, such as one-by-fours, etc. may be used, as desired.

In FIGS. 15 and 16, a splice 360 to a wave division multiplexer (WDM)  
25 361 allows for module 24 to have wavelength division multiplexing functions associated with connection locations 91. A "dense" wave division multiplexer may be used, if desired (DWDM). For the multiplexing function, row 362 of connection locations 91 could serve as the first wavelength ports, and row 364 could serve as the

different wavelength ports. Each pair of connection locations 91 (one from each row) would be linked to one of the fibers of cable 300 in FIG. 15.

FIG. 17 shows just a splicing component 370 so that each fiber of cable 300 could be spliced to a fiber leading to one connection location 91. Other passive optical components can be selected as desired to provide module 24 with the desired function or functions.

Referring now to FIGS. 22 and 23, blank panels 150, 170 comprising modules 23 are shown. Each blank panel 150, 170 includes a generally planar front 152, and flanges 154 including holes 158, 160 to enable mounting of the blank modules 150, 170 to frame 22. Blank modules 150, 170 are utilized to fill open spaces of frame 22. Blank module 170 is a single width, and blank module 150 is a double width. Additional widths can be supplied as desired.

During assembly of a system for a particular outside plant application, the desired function (cross-connect, interconnect, other) is selected. The types of modules 23 (connection, storage, blank) and widths of modules 23 are also selected. Further the types of connections and whether any optical splices or optical couplers are to be utilized are selected. The appropriate modules are selected and then mounted to frame 22 within an enclosure 20. Over time, the modules 23 can be removed for repair, replacement, or to change functions. Also, the front connections can be changed as the need arises.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.